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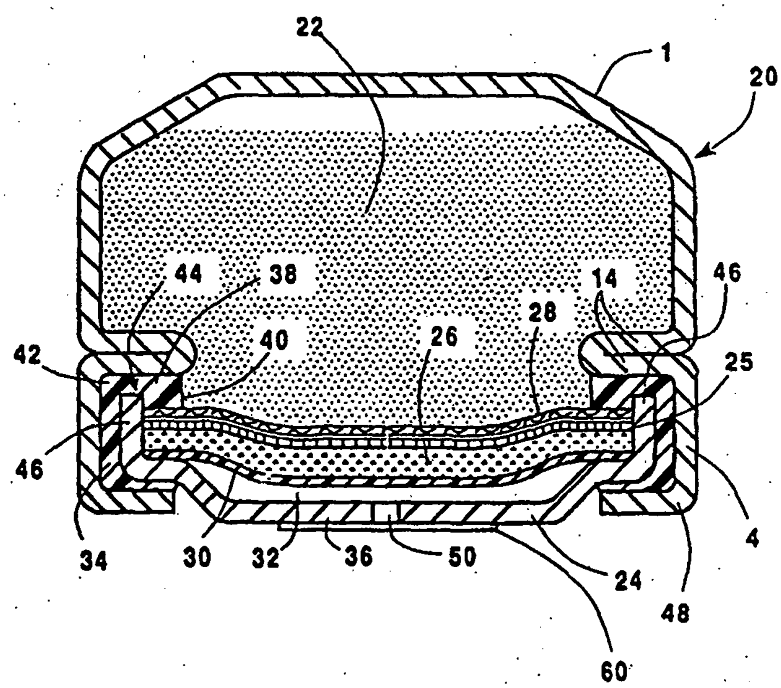
(54) Title: ELECTRODE CUP FOR GALVANIC CELL

(57) Abstract

A galvanic cell (20), especially a miniature cell, comprises first and second electrodes (22, 26) of opposite polarity, a separator (28) and an electrolyte, contained in a two-part housing of a cup (1) and a can (24) sealed with an insulating gasket (34), wherein the cup comprises an inwardly beaded area (14) and the gasket is seated in the cup on the inwardly beaded area. The bead is preferably disposed in the vicinity of the open end of the cup, and preferably a low profile can and gasket are used, so that effectively the majority of the cross section thickness of the vertical portion of the cell housing is attributed to only the thickness of the wall of the cup and thus maximum internal volume of the cell is reserved for active cell components. A process for producing the cell with the beaded cup is also disclosed.



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ELECTRODE CUP
FOR GALVANIC CELL

This invention relates to galvanic cells, in particular to miniature cells employing a cup and can assembly that occupies a relatively small volume so that the internal volume of the cell is reserved primarily for the active components of the cell. This invention also relates to a process for producing galvanic cells having an optimum internal volume for the active components of the cell.

The miniaturisation of electronic devices has created a demand for small but powerful electrochemical cells. Cells that utilise an alkaline electrolyte are known to provide high energy density per unit volume and are therefore well suited for applications in miniature electronic devices such as cameras, hearing aids, watches and calculators.

However, alkaline electrolytes, such as aqueous potassium hydroxide and sodium hydroxide solutions, have an affinity for wetting metal surfaces and are known to creep through the sealed metal interface of an electrochemical cell. Leakage in this manner can deplete the electrolyte solution from the cell and can also cause a corrosive deposit on the surface of the cell that detracts from the cell's appearance and marketability. These corrosive salts may also damage the device in which the cell is housed. Typical cell systems where this problem is encountered include silver oxide-zinc cells, nickel-cadmium cells, air depolarised cells, and alkaline manganese dioxide cells.

In the prior art, it has been a conventional practice to incorporate an insulating member or gasket between the cell cup and can so as to provide a seal for the cell. Generally, the gasket must be made of a material that is electrically insulating and that is inert to the electrolyte contained in the cell and the cell environment. In addition, it has to be flexible and resistant to cold flow under pressure of the seal and must maintain these characteristics so as to ensure a proper seal for a long period of storage. Materials such as nylon, polypropylene, ethylene-tetrafluoroethylene copolymer and high density polyethylene have been found to be suitable as gasket materials for most applications.

Typically, the insulating gasket is annular and, in cross-section, in the form of a "J"-shaped configuration including a "U"-shaped portion into which the extended wall of the cup may be inserted, so that, upon radially squeezing the edge of the can, the bottom portion of the gasket forms a seal with the bottom portion of the wall of the cup.

To better ensure a good seal, a sealant is generally applied to the gasket, including the internal "U"-shaped portion of the gasket, so that, upon insertion of the cup into the gasket, the edge of the extended wall of the cup seats in the sealant and thus, upon the application of a radial squeeze, forms a good seal between the cup and the can.

The gasket generally extends the entire height of the internal wall of the cell, and the volume of space occupied by the gasket could exceed as much as 20% of the internal volume of the cell. Thus, the gasket, which is necessary for sealing the cell, reduces the space usefully available for the active components of the cell.

In the conventional cell construction using a flat positive electrode, an electrode dome can be caused by bulging or flexing of the central area of the electrode towards the centre of the cell when the cell is sealed. The electrode dome is the result of electrode compression at the circumferencial edge of the electrode by the gasket. This is seen as a problem because, for example, the electrode dome reduces the internal volume in the negative electrode compartment.

It would therefore be desirable to be able to provide a cell construction for galvanic cells that can make more space usefully available in the cell, such as for increasing the volume of active materials contained in the cell. It would also be desirable to be able to provide a process for producing such a cell construction for galvanic cells. Furthermore, it would be desirable to be able to avoid the problem associated with electrode doming.

We have now found, surprisingly, that these aims can be achieved by a cell construction employing a beaded electrode cup, and by a process for producing a beaded electrode cup, in accordance with the present invention.

Accordingly, in a first aspect, the present invention provides galvanic cell comprising first and second electrodes of opposite polarity, a separator and an electrolyte, contained in a two-part housing of a cup and a can sealed with an insulating gasket, wherein the cup comprises an inwardly beaded area and the gasket is seated in the cup on the inwardly beaded area.

In a second aspect, the present invention provides process for producing a galvanic cell comprising forming a cup from a conductive sheet of material, reforming the cup to reverse a portion of the peripheral wall at the open end of the cup upon itself to produce a double walled segment, reforming the cup to reverse a portion of the peripheral wall extending from the double walled segment upon itself to produce a triple walled segment, reforming the cup to dispose the inner two walls of the triple walled segment substantially perpendicularly to the outer wall of the triple walled segment to form an inwardly beaded area, introducing first and second electrodes, a separator and an electrolyte into the cup and a can, and sealing the can in the cup with an insulating gasket seated in the cup on the inwardly beaded area.

Advantageously, the cell structure in accordance with the present invention employs an inward beaded contour cup and a can housing that occupies a minimum internal volume for the cell. Another advantage is that the use of an inward beaded contour cup and a can housing for a cylindrical cell allows the use of a low profile gasket to provide a seal for the cell, so that the cell has a large internal volume for its active components. Yet another advantage is that the cell housing employing an inward beaded contour cup and can is easy to make, cost effective to produce and easy to assemble. A further advantage is that the inward beaded contour cup and the gasket provide an improved seal for the cell.

In one embodiment of the first aspect, a galvanic cell comprises a first electrode having a polarity; a second electrode of opposite polarity; a separator between the first electrode and the second electrode; an electrolyte; a two-part conductive housing containing the first electrode, the second electrode, the separator and the electrolyte, the first part of the housing being a can electrically connected to the first electrode and having a wall and an edge defining an opening, and the second part of the housing being a cup

electrically connected to the second electrode, preferably the negative electrode, and having an upstanding wall with an outer surface and an edge end defining an opening and having an inward beaded area at the vicinity of the open end of the cup, and an insulating gasket comprising a base member and at least one upstanding wall, preferably an outer wall and an inner wall spaced apart from the outer wall thereby defining a "U" shaped groove; wherein the edge of the can's wall is disposed against the gasket, preferably within the groove of the gasket; one upstanding wall of the gasket is disposed between the wall of the can and the wall of the cup; and the base member of the gasket is seated on the beaded area of the cup producing a sealed galvanic cell.

The can preferably has an outward embossment at its central area. In a preferred embodiment, the can is a cylindrical can having a peripheral upstanding wall with an inner upstanding surface, the first electrode is a disc and the outer diameter of the disc is larger than the inside diameter of the inner upstanding wall of the can.

In an embodiment of the second aspect, a process for assembling the components of a cell into a two-part conductive housing in which one part is a cup and the other part is a can, comprises the steps:

a) forming a cup having a base member and peripheral wall defining an opening from a conductive sheet of material;

b) reforming and reversing the base of the cup of step a) to reverse a portion of the peripheral wall at the opening upon itself to produce a two member first segment;

c) reforming the cup of step b) to reverse a portion of the peripheral wall extending from the first segment upon itself to produce a three member second segment;

d) forming an internal bead on the wall of the cup comprising two members of the second segment disposed perpendicular to the peripheral wall and the third member of the second segment being the portion of the wall defining the opening and disposed parallel to the peripheral wall;

e) preparing an electrically insulating gasket;

f) preparing a conductive can with a peripheral wall having an edge defining an opening for the can;

g) placing the components of the cell within the cup and the can and then placing the can into the cup so that the wall of the can is in parallel alignment with the wall of the cup, the gasket is disposed in physical contact between the wall of the cup and the wall of the can, and the gasket is seated on the internal bead of the wall of the cup; and,

h) securing the cup, the gasket and the can so as to effectively seal the cell and thereby electrically insulate the can from the cup.

In step f) the can is preferably formed with an outward central embossment. In a preferred embodiment, the can is a cylindrical can and a positive electrode disc is disposed between the peripheral wall of the can, the outer diameter of the positive electrode disc being larger than the inner diameter of the wall of the can.

In conventional types of miniature galvanic cells, the height of the upstanding peripheral wall of the gasket usually extends the entire height of the can's upstanding peripheral wall. This type of conventional housing for miniature galvanic cells requires that the thickness of the assembled housing includes a three-wall assembly: (1) can wall, (2) gasket wall and (3) cup wall. The internal volume for the conventional type housing for a fixed size cell is reduced by the thickness of the three-wall assembly. This results in a waste of space in the cell for active components of the cell.

Contrary to this type of conventional miniature galvanic cell, the housing for cells of the present invention provides only a single wall thickness (the cup's upstanding wall) for most of the vertical component of the housing, as illustrated in Figure 6. Thus, the internal volume of the housing is maximised to accommodate more of the active materials of the cell. Specifically, the beaded area of the cup is disposed at the vicinity of the open end of the cup so that the majority of the height of the upstanding peripheral wall of the cup is disposed above the beaded area, as illustrated in Figure 6, so that the cross-sectional thickness of the housing is substantially composed only of the thickness of the wall of the cup. Accordingly, the can of the housing of the present invention has an upstanding peripheral wall that preferably is much smaller in height than the conventional upstanding peripheral wall of cans of cells of the prior art.

We have also found that the formation of an electrode dome in a flat electrode can be effectively eliminated by controlling the material flex direction. Accordingly, a mechanism has been found that will set the flex direction and also provide room to accommodate the deflection. The flex direction can be controlled by simply blanking an oversize disc electrode to fit the can, preferably bowing the central portion of the electrode toward the can bottom during insertion into the can and controlling or preventing compression of the peripheral portion of the electrode when the cell is sealed. The effect is similar to the use of a wedge type washer. The wedging of the electrode also provides excellent electrical contact of the metallic screen typically present in the electrode, with the can. Preferably, to accommodate the electrode, the cathode can may contain a shallow outward embossment in the central area of its base, as shown for example in Figure 6. The embossed can also provides a controlled gap for uniform air diffusion across the surface of the electrode membrane of an air depolarised cell.

The housing geometries of the present invention accomplish two important benefits. First, the removal of the upstanding wall of the can and outer wall of the gasket above the indented area allows the negative cup compartment to be expanded without increasing the outer diameter of the cell. Second, by providing direct compressive contact between the gasket and the beaded contour of the cup, rather than positioning the peripheral area of the electrode in the interface, the seal will be improved.

Preferably, the beaded area of the cup's wall is composed of a portion of the cup's wall folded upon itself. The beaded area is disposed at the vicinity of the open end of the cup and provides a support for the gasket, preferably a low profile gasket, during sealing of the cell. Thus, the gasket will be compressed between the bead and the rim of the can when the cell is sealed.

Preferably, the gasket has an inner wall that is seated on the peripheral area of the separator of the cell to secure the first electrode within the can of the cell. It will be appreciated that a ring or similar component may be disposed between the inner wall of the gasket and the separator so that the inner wall of the gasket would be seated on the separator via the ring or other type of component, preferably a firm component. Thus,

preferably the peripheral area of the first electrode will be compressed between the base of the can and the inner wall of the gasket when the cell is sealed. Alternatively, the bottom surface of the inner wall of the gasket or ring is angled downward and inward, supporting the peripheral area of the first electrode and separator with compression, such that the first electrode is not domed.

The beaded area preferably is located proximate to the open end of the cup so that it is nearer to the rim of the cup than to the base of the cup. More preferably, the beaded area has a surface perpendicular to the wall of the cup and the surface is disposed nearer the open end of the cup such that the vertical height from the open end of the cup to the perpendicular beaded surface is between about 5% and about 40%, more preferably between about 8% and about 30%, and most preferably located between 10% and 25%, of the vertical height of the cup. As shown in Figure 5, the vertical height from the open end of the cup to the beaded contour is represented by B, and the vertical height of the cup being the length of the upstanding wall of the cup measured from the open end of the cup is represented by A. Accordingly, in the sealed cell, the cell housing below the bead as shown in Figure 5 can consist of only the single wall thickness of the cup, thereby providing maximum useful space for active cell materials.

In some applications, a conductive label may be required to provide an electrical contact point at the side of the cell. This feature can be accomplished by utilising a film having an electrically insulating adhesive inner layer adapted to be secured to the negative cup wall. The outer layer would be an electrically conductive surface that would provide electrical contact to the can of the cell and therefore the side of the cell would serve as the terminal of the can or positive terminal.

The gasket used in the present invention comprises a material selected with consideration given to its stability in the presence of the electrolyte, its resiliency, and its resistance to cold flow. Suitable polymeric materials include nylon, polytetrafluoroethylene, fluorinated ethylene-propylene, chlorotrifluoroethylene, perfluoro-alkoxy polymer, polyvinyls, polyethylene, polypropylene, and polystyrene. Other suitable materials would be recognisable by one skilled in the art. In some applications, additional

precautions can be used in conjunction with the gasket to provide a more effective seal, such as coating selected areas of the gasket with a sealing agent such as a fatty polyamide resin or asphalt. Preferably, a low profile gasket is used.

The cell and method according to the present invention may be applicable to any appropriate cell size or type. Preferably, the cell is a miniature cell, more preferably a miniature air depolarised cell, and in particular a miniature zinc-air cell in which the second electrode is the negative electrode comprising zinc and electrolyte.

For example, in a preferred construction of a miniature zinc-air cell, the positive electrode (air electrode) can comprise manganese dioxide, activated carbon, and electroconducting acetylene black, with further addition of polytetrafluoroethylene (PTFE) dispersion, to provide a mix that can be applied on a metallic screen. The layer of polytetrafluoroethylene covers the entire base of the can including the air distribution membrane. The negative electrode (anode) comprising zinc powder is placed in the cup and makes electronic contact with the cup. The negative electrode may comprise a mixture of zinc particles, electrolyte and organic compounds such as binders which make up the battery's negative electrode. The cup can for example be made from a trilaminate material comprising copper that has been laminated to the bare side of a nickel-clad steel strip. A nickel layer could be used to protect the exterior surface of the steel strip. Other laminated materials from which the cup may be made include a bilaminate of copper on a stainless steel substrate and a laminate made from more than three layers. Round disks punched from this laminated metal strip can then be formed into a cup. The copper layer forms the inside surface of the cup and directly contacts the negative electrode mixture.

The present invention will be further illustrated by reference to the accompanying drawings, in which:

Figure 1 is a cross-sectional view of a negative cup for use in an air depolarised cell.

Figure 2 is a cross-sectional view of the modification of the cup shown in Figure 1.

Figure 3 is a cross-sectional view of the modification of the cup shown in Figure 2.

Figure 4 is a cross-sectional view of the modification of the cup shown in Figure 3.

Figure 5 is a cross-sectional view of the modification of the cup shown in Figure 4.

Figure 6 is a cross-sectional view of a finished air depolarised cell showing the cup of Figure 5 with a gasket, negative electrode, electrolyte and a can with a positive electrode after the wall of the cup was crimped to provide a sealed cell.

Figure 1 shows a circular cup 1 having a base 2 and an upstanding peripheral wall 4 defining an opening 6. The cup 1 could be formed by drawing a blank conductive disc using a concentric forming punch and a draw die.

Figure 2 shows cup 1 formed as shown in Figure 1 followed by a reverse redraw operation to fold the portion 8 of the wall defining the opening on itself to produce a folded segment 10.

Figure 3 shows the cup 1 of Figure 2 in which the folded segment 10 is folded back upon itself producing a three-folded segment 12. Forming a bead can be accomplished by bending inwardly the inner folded segment to form an inner fold 14 as shown in Figure 4. The beaded area will help constrain the gasket of the cell as shown in Figure 6. The bending of the inner fold 14 can be done to produce the desired bead 14 as shown in Figure 5.

As shown in Figure 5, the outer diameter of the cup of Figure 4 is reduced so that the upper section 16 of the cup will be in alignment with the remaining vertical portion of the peripheral wall 4. All identical parts shown in Figures 1 through 6 will be identified with their respective members.

Figure 6 shows an assembled cell 20 comprising the cup 1 containing the anode 22, and a can 24 containing an air electrode 26. The cell 20 also contains separator 28, nickel screen 25, air electrode 26, polytetrafluoroethylene (PTFE) layer 30, an air distribution membrane 32 and gasket 34. The cup 1 is identified with the same component parts as in Figure 5. The can 24 is shown with a central outward shallow embossed section 36. As discussed above, the shallow embossed section 36 will serve to accommodate an oversize electrode 26 while also serving as a controlled gap for uniform air diffusion across the surface of the electrode.

As shown in Figure 6, gasket 34 has a base 38, an inner wall 40 and an outer wall 42 forming a groove 44 that accommodates the peripheral wall 46 of can 24. The beaded section 14 of cup 1 supports the base 38 of gasket 34 during the sealing operation of the cell 20. As discussed above, a ring or similar object could be disposed between inner wall 40 of gasket 34 and peripheral section of the separator 28 to secure the air electrode assembly during and after sealing of the cell. Alternatively, a separate ring or similar object could replace the inner wall of the gasket, or the inner wall of the gasket could be eliminated, with the base of the gasket making direct contact with the separator. The air electrode 26 is shown in Figure 6 with an outer diameter larger than the inner diameter of the peripheral wall 46 of can so that the air electrode 26 will be wedged within the can 24 and make excellent electrical contact with nickel screen 25. The shallow embossed section 36 will accommodate the oversized air electrode 26.

As shown in Figure 6, the edge 48 of the wall 4 of the cup 1 is shown compressed against the electrically insulating gasket 34 between the cup 1 and the can 24 thereby forming a seal and an electrical barrier between the can 24 and the cup 1.
As shown in Figure 6, hole 50 is punched into the bottom of can 24 to act as an air-entering port. A strip of tape 60 is shown to seal the hole 50 prior to use. The cell shown in Figure 6 has the can 24 in electrical contact with electrode 26 and the cup 1 in electrical contact with electrode 22 and thus the terminals of the cell are at opposite ends.

CLAIMS:

1. A galvanic cell comprising first and second electrodes of opposite polarity, a separator and an electrolyte, contained in a two-part housing of a cup and a can sealed with an insulating gasket, wherein the cup comprises an inwardly beaded area and the gasket is seated in the cup on the inwardly beaded area.

2. A cell according to claim 1 wherein the inwardly beaded area is proximate to the open end of the cup.

3. A cell according to claim 2 wherein the inwardly beaded area is formed with a surface substantially perpendicular to the wall of the cup, the vertical height from the open end of the cup to the surface being between 5% and 40%, preferably between 8% and 30%, of the vertical height of the cup.

4. A cell according to any preceding claim wherein the gasket is compressed between the rim of the can and the inwardly beaded area of the cup.

5. A cell according to any preceding claim wherein the first electrode is a flat electrode contained in the can and covered by the separator, and the first electrode and separator are peripherally supported between the gasket and the base of the can, preferably without compression, such that the first electrode is not domed.

6. A cell according to any preceding claim wherein the base of the can comprises an outwardly embossed central area.

7. A cell according to any preceding claim wherein the can, first electrode and separator are cylindrical and the outer diameter of the first electrode is larger than the inner diameter of the can.

8. A cell according to any preceding claim wherein the cell is an air depolarised cell in which the second electrode is the negative electrode, the negative electrode preferably comprising zinc and electrolyte.

9. A cell according to any preceding claim which is a miniature cell.

10. A process for producing a galvanic cell comprising forming a cup from a conductive sheet of material, reforming the cup to reverse a portion of the peripheral wall at the open end of the cup upon itself to produce a double walled segment, reforming the cup to reverse a portion of the peripheral wall extending from the double walled segment upon itself to produce a triple walled segment, reforming the cup to dispose the inner two walls of the triple walled segment substantially perpendicularly to the outer wall of the triple walled segment to form an inwardly beaded area, introducing first and second electrodes, a separator and an electrolyte into the cup and a can, and sealing the can in the cup with an insulating gasket seated in the cup on the inwardly beaded area.

11. A process according to claim 10 wherein the gasket is compressed between the rim of the can and the inwardly beaded area of the cup when the can and cup are sealed.

12. A process according to claim 10 or claim 11 wherein the first electrode is flat and is introduced into the can with the separator whereby the first electrode and separator are peripherally supported between the gasket and the base of the can, preferably without compression, such that the first electrode is not domed when the can and the cup are sealed.

13. A process according to any of claim 10 to 12 wherein the can is formed with an outwardly embossed central area in its base.

14. A process according to claim 13 wherein the can, first electrode and separator are cylindrical and the outer diameter of the first electrode is larger than the inner diameter of the can whereby the central area of the first electrode is accommodated in the embossed area of the can.

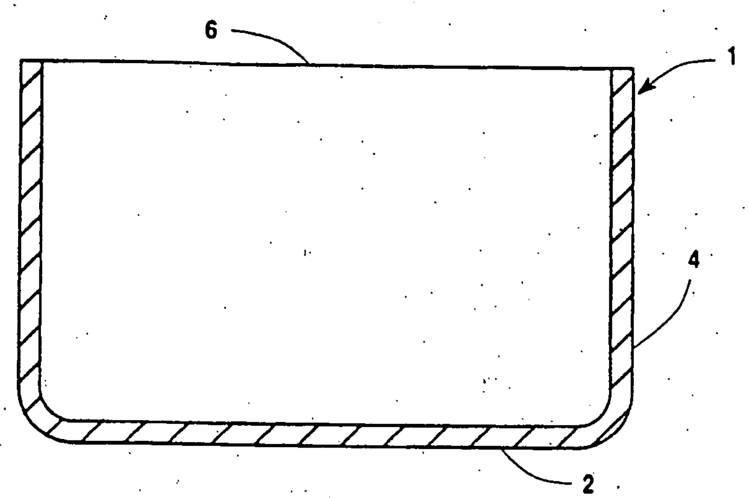

Fig. 1

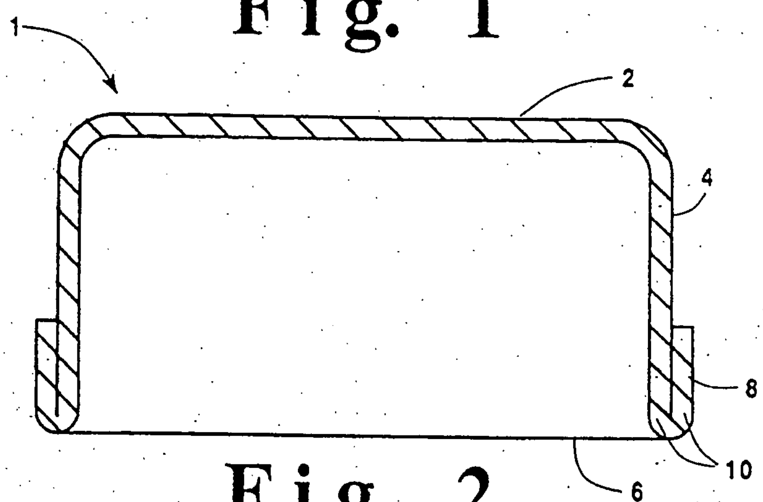

Fig. 2

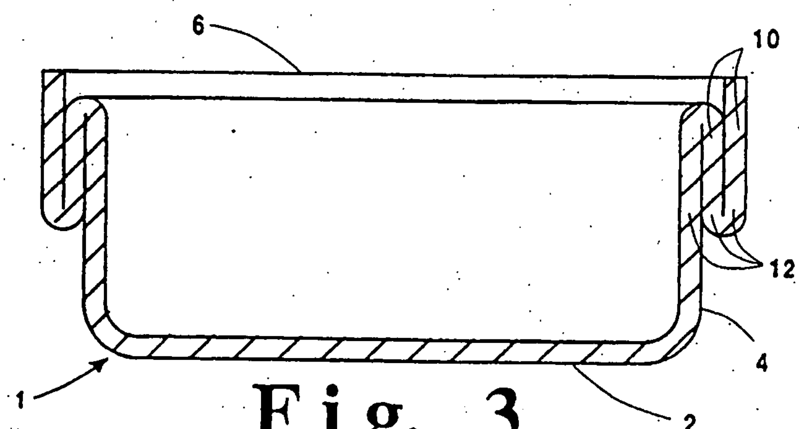

Fig. 3

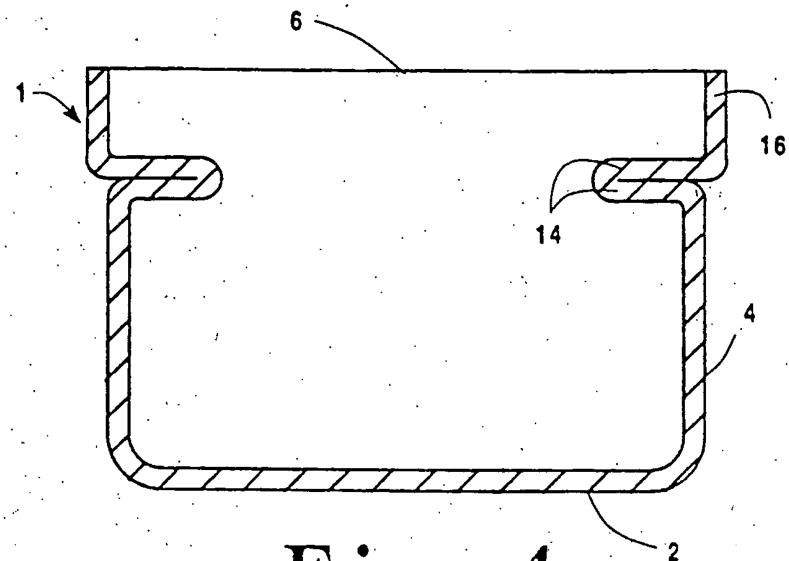

Fig. 4

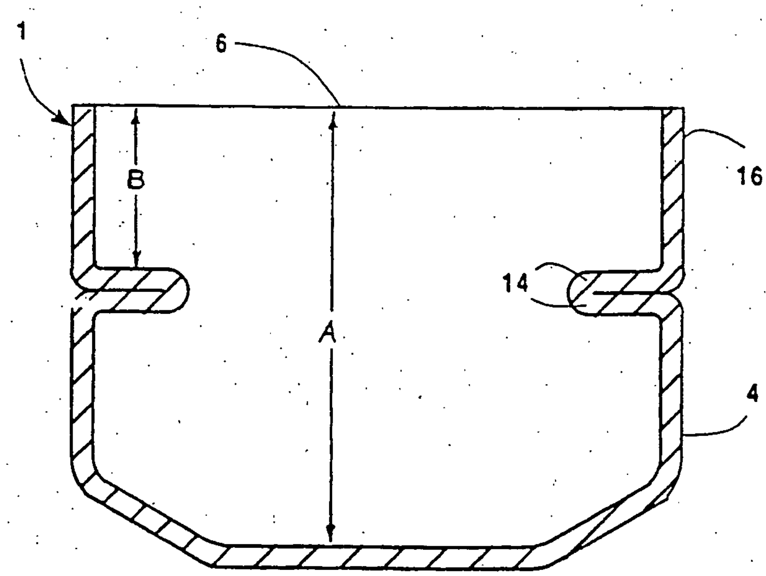

Fig 5

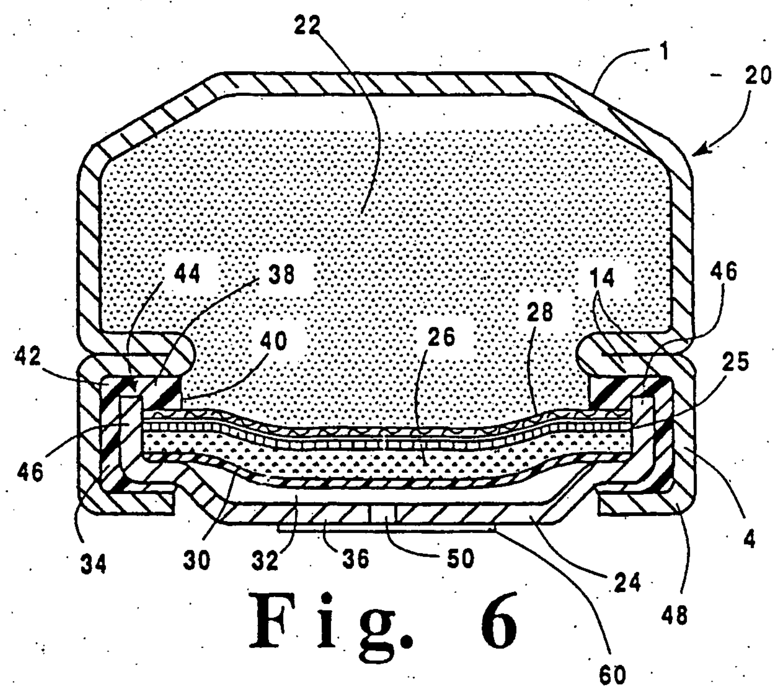

Fig. 6

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 99/08927

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H01M2/02 H01M10/04 H01M6/12 H01M12/06 H01M2/04

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 H01M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4 240 197 A (HAMSAG ERNEST E) 23 December 1980 (1980-12-23) figure 9 column 2, line 32 - line 49 column 3, line 30 - line 36 ---	1-4,9
P,A	US 5 846 672 A (BENNETT WILLIAM R) 8 December 1998 (1998-12-08) figure 5 column 2, line 24 - line 34 column 2, line 47 - line 56 column 3, line 18 - line 31 column 5, line 10 - line 31 ---	1,6,8,9
A	US 3 909 303 A (ROSANSKY MARTIN G ET AL) 30 September 1975 (1975-09-30) figure 1 ---	1-3
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[X] Further documents are listed in the continuation of box C.

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Date of the actual completion of the international search	Date of mailing of the international search report
11 August 1999	19/08/1999

Name and mailing address of the ISA	Authorized officer
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INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 99/08927

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